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Description

[0001] This invention relates to an optical disk recording device of a type which records information by projecting laser beam on a recording surface of an optical disk to form pits thereon and, more particularly, to an optical disk recording device of this type capable of preventing occurrence of an adverse effect to signal-to-noise ratio of a wobble signal when recording is made by using a higher recording speed than a normal recording speed.

[0002] As a manner of recording information on a write-once type optical disk on the basis of the CD-WO (CD Write Once) standard, it has been proposed to record information by using not only a normal speed but also a higher speed than the normal speed such as a double speed and a quadruple speed. By using such high speed recording, for example a quadruple speed, it is possible to store data such as CD-ROM data and audio data in a hard disk, read the stored data in the form of quadruple compressed data, and record the read out data by driving an optical disk at a quadruple speed. In case a double speed is employed, for example, a Compact Disc player may be driven at a double speed and an optical disk may be driven at a double speed also to copy reproduced data.

[0003] In a prior art optical disk recording device, it has been proposed to perform a high speed recording by increasing power (pit power) of recording laser beam in a pit forming section (i.e., pit period) as shown in Fig. 2 for accurately forming pits on the optical disk.

[0004] According to the CD-WO standard, a groove called "pregroove" is preformed on the recording surface of an optical disk and, during recording of information, recording is made by tracking this pregroove under a tracking control. This pregroove is not a straight line but is undulated with a particular frequency and this undulation is called "wobble". In the recording mode, this wobble is detected on the basis of a residual component of a tracking error signal and a CLV (constant linear velocity) spindle control is realized by PLL-controlling a disk motor so that the frequency of the detected wobble will become a predetermined frequency (e.g., 22.05 kHz in a normal recording speed mode).

[0005] If the device is designed in a manner to detect a tracking error constantly, a DC offset component of a tracking error signal will increase and a signal-to-noise ratio will be deteriorated due to influence caused by a signal at a pit position and this will cause an adverse effect on the tracking control and the spindle control based on the wobble signal and will also make it difficult to obtain ATip information (time information) contained in the wobble signal. Therefore, in a bottom period in which a pit is not formed, an attempt has been made to detect a tracking error in only a bottom period in which laser beam of a low power (bottom power) which is insufficient for forming a pit is projected (Fig. 2) and hold

a tracking error signal of an immediately preceding value in a pit period.

[0006] For detecting a tracking error only in the bottom period, it is necessary, for obtaining a wobble signal of an adequate signal-to-noise ratio, to make as much time as possible in the bottom period available for detection of a tracking error signal. It is therefore desirable to make the whole bottom period available but, actually, as shown in Fig. 3B, the waveform of reflected beam from a disk has a delayed trailing edge as compared with a laser diode output shown in Fig. 3A and this causes leakage (a shaded portion in Fig. 3B) of a signal in the pit period to a bottom period. A frequency range of this leakage signal portion extends over a frequency range of the wobble signal as well as a frequency range of an EFM signal. Therefore, when a tracking error is detected throughout the entire bottom period, the signal-to-noise ratio of the wobble signal is deteriorated rather than it is improved.

[0007] Since the trailing edge of the waveform of the reflected beam from the disk assumes an exponential curve, it is necessary to determine a fall period Δt in such a manner that the trailing edge is decayed to such an extent that influence of the signal in the pit period is reduced and an adequate length of a tracking error signal detection period can be made available and to perform detection of a tracking error during the bottom period excluding this fall period Δt . In this case, the fall period Δt is determined at a length at which the best signal-to-noise ratio of the wobble signal is available by minimizing the influence of the signal in the pit period and maximizing the tracking error detection period.

[0008] The value of the fall period Δt thus determined is relatively small when the recording speed is a normal (one time) speed but, when the recording speed becomes higher than the normal speed, a relatively long fall period Δt is required as shown in Fig. 3C because it takes more time for the waveform of the reflected beam to decay completely. This results in shortening of the tracking error detection period with resulting deterioration of the signal-to-noise ratio of the wobble signal.

[0009] Further information relating to the prior art can be found in US-A-5 170 382 and DE-A-36 44 313.

[0010] DE-A-36 44 313 relates to a recording and reproduction apparatus for optical information with a single semi-conductor laser for recording information bits on an optical recording film in the writing mode with laser light that depends on a driving current modulated by an information signal and for radiating a constant reading laser light onto the recording film in reading mode in order to reproduce signals recorded on the recording film.

[0011] US-A-5 170 382 discloses a magneto optical apparatus for recording an information signal on a disk by illuminating a magnetic layer on a disk with a pulsed laser beam and applying a magnetic field with a polarity switched according to the information signal to the spot illuminated by the laser beam. Said apparatus compris-

ing means for controlling the peak power level as well as the bottom power level of the laser beam depending on the radius at which the data is recorded.

[0012] It is, therefore, an object of the invention to provide an optical disk recording device capable of preventing occurrence of deterioration of signal-to-noise ratio of a wobble signal when the recording speed is changed.

[0013] For achieving the above described object of the invention, according to the invention, not only a pit power of recording laser beam but also a bottom power of recording laser beam is increased as a recording speed increase ratio is increased.

[0014] For this purpose, an optical disk recording device according to claim 1 is provided.

[0015] According to the invention, in a case where recording is made at a higher recording speed, not only the pit power but also the bottom power of the recording laser beam is increased and, accordingly, difference between the pit power and the bottom power is reduced as compared with a case where the pit power only is increased. As a result, time required for the waveform of the reflected beam to fall is reduced and an adequate time is made available for detection of a tracking error, so that deterioration of the signal-to-noise ratio of the wobble signal can be prevented.

[0016] Further, since recording is made at a higher recording speed increase ratio, an erroneous forming of a pit can be prevented in spite of the increased bottom power.

[0017] Furthermore, according to the invention, the increase in the bottom power enables the leading edge of a pit power of a next pit period to become sharp and thereby reduces an error in the start position of pit forming.

[0018] Preferred embodiments of the invention will be described below with reference to the accompanying drawings.

In the accompanying drawings,

[0019]

Fig. 1 is a block diagram showing functions of a main portion of an embodiment of an optical disk recording device according to the invention shown in Fig. 4;

Fig. 2 is a waveform diagram showing a laser power control according to a prior art optical disk recording device;

Figs. 3A to 3D are waveform diagrams showing change in reflected laser beam waveforms according to the control of Fig. 2;

Fig. 4 is a block diagram showing an entire structure of an optical disk recording and reproducing device incorporating an embodiment of the invention;

Fig. 5 is a circuit diagram showing an example each of a tracking error detection circuit 31 and a sample

hold circuit 33 shown in Fig. 1;

Fig. 6 is a circuit diagram showing an example of a laser power control circuit 25 of Fig. 1;

Figs. 7A to 7C are waveform diagrams showing an example of a laser power control by the circuit of Fig. 6; and

Fig. 8 is a circuit diagram showing a specific example of the circuit of Fig. 6.

[0020] An embodiment of the invention will now be described. In this embodiment, information is recorded on a write-once type disk of a dye system with the CD-WO standard and a recording speed is variable between one time speed (x1), i.e., normal speed, a double speed (x2) and a quadruple speed (x4). Fig. 4 shows the entire structure of an optical disk recording and reproducing device to which this invention is applied. In an input section 28, a recording speed increase ratio is set by a manual operation by an operator or other means. A disk servo circuit 16 controls rotation of a disk motor at a constant linear velocity and at the set recording speed increase ratio in response to a command from a system controller 19.

[0021] A focus servo and tracking servo circuit 18 controls, in response to a command from the system controller 19, a focus and a tracking of laser beam 11 projected from a semiconductor laser provided in an optical head 13. The tracking control is carried out by detecting a pregroove formed on a disk 10. A feed servo circuit 17 drives a feed motor 20 in response to a command from the system controller 19 to displace the optical head 13 in the radial direction of the disk 10.

[0022] An input signal to be recorded on the optical disk 10 is applied to a data signal forming circuit 22, directly when the signal is a digital signal or through an analog-to-digital converter when the signal is an analog signal, at a speed corresponding to the set recording speed increase ratio. The data signal forming circuit 22 applies interleave to input data to give an error check code to the input data and provides the input data with TOC information and subcoding information generated by a TOC and subcoding generation circuit 23, and EFM modulates the input data to form and output a series of serial data at a transfer rate based on a format of the CD standard and at the set recording speed increase ratio.

[0023] This data is applied through a drive interface 15 to a data signal correction circuit 26 in which the data is subjected to modulation by (n-1) strategy and thereafter is applied to a laser generation circuit 25. The laser generation circuit 25 drives, in response to the data signal, the semiconductor laser in the optical head 13 to project laser beam on the recording surface of the optical disk 10 and thereby record the data by forming pits. The laser power (i.e., pit power and bottom power) during this recording is designated at values corresponding to the recording speed increase ratio according to the invention and is controlled accurately to these designated values by an ALPC (automatic laser power con-

trol) circuit provided in the laser generation circuit 25. By this processing, data is recorded on the optical disk 10 in accordance with the format, transfer speed and linear velocity (1.2 m/s to 1.4 m/s) of the CD standard.

[0024] When the data is reproduced by projecting reproducing laser beam on the optical disk 10 in which the data has been recorded in the above described manner, the read out data is demodulated by a signal reproduction and processing circuit 30 and is delivered out either directly as a digital signal or an analog signal through a digital-to-analog converter 32.

[0025] Fig. 1 is a control block diagram by the optical disk recording and reproducing device of Fig. 4.

[0026] A recording speed increase ratio setting section 28 (the input device 28 of Fig. 4) is operated by a manual operation by an operator or other means to set the recording speed increase ratio. A projection time control section 26 (the data signal correction circuit 26 of Fig. 4) subjects an input EFM signal to modulation by (n-1) strategy and thereby controls the projection time of the laser beam 11. A laser power control section 25 (the laser generation circuit 25 of Fig. 4) changes the pit power in the pit period in accordance with the recording speed increase ratio. More specifically, as the recording speed increase ratio becomes larger, an input heat value per unit length decreases and this makes it difficult to form a pit, so that the pit power is increased to form a proper pit. Simultaneously with the increase in the pit power, the bottom power is also increased to avoid change in difference between the pit power and the bottom power so as to prevent increase in the fall time of the reflected laser beam waveform.

[0027] The laser beam reflected on the optical disk 10 is received by a beam receiving element in the optical head 13 through an objective lens. This received beam signal is supplied to the signal reproducing and processing circuit 30 (Fig. 4) through an RF amplifier 35.

[0028] The tracking error detection circuit 31 detects a tracking error from the received beam signal. The detected tracking error signal is applied to a driver 38 through a sample hold circuit 33 and a filter 36 to drive a tracking actuator in the optical head 13 to perform the tracking control.

[0029] The sample hold circuit 33 passes a tracking error signal in the bottom period excluding the fall period of a reflected waveform and holds and outputs an immediately preceding tracking error signal in the pit period and the fall time Δt . The filter 36 is provided for smoothen a step produced in the tracking error signal at a hold releasing timing. In a playback mode, the sample hold circuit 33 constantly passes a tracking error signal without holding.

[0030] A bandpass filter 40 extracts a wobble signal from the tracking error signal and outputs it. Since the frequency band of the wobble signal varies depending upon the recording speed increase ratio, that is, 22.05 kHz at the normal speed, 44.1 kHz at the double speed

and 88.2 kHz at the quadruple speed, the transmission frequency band of the bandpass filter 40 needs to be changed in accordance with the frequency of the wobble signal. For example, the transmission frequency band is set to 10 kHz to 30 kHz at the normal speed and changed to a frequency band having the frequency of the wobble signal as its center frequency as the recording speed increase ratio is changed. An ATip information detection circuit 42 demodulates and outputs ATip information, i.e., time information, which is contained in the form of FM modulated data in the wobble signal.

[0031] A reference frequency generation circuit 44 produces, in response to the set recording speed increase ratio, a reference frequency of the wobble signal, i.e., 22.05 kHz at the normal speed, 44.1 kHz at the double speed and 88.2 kHz at the quadruple speed. A phase comparator 46 compares the phase of the detected wobble signal with the phase of the reference frequency and produces a phase error signal. This phase error signal is smoothed by a low-pass filter 48 and then is applied to a rotation control section 16 (the disk servo circuit 16 of Fig. 4). The rotation control section 16 PLL controls the disk motor 12 so as to bring the phase error to a predetermined value and thereby performs a spindle control of the CLV system.

[0032] An example of the tracking error detection circuit 31 and an example of the sample hold circuit 33 are shown in Fig. 5. A laser beam detector 52 provided in the optical head 13 is made of a four-split PIN photodiode and detects laser beam reflected from the optical disk 10. Detected signals from split sections on the same side of the track of the laser beam detector 52 are combined together and are applied to the tracking error detection circuit 31 and the sample hold circuit 33 through current-voltage converting amplifiers 37 and 39. These signals are applied to a subtractor 58 through analog switches SW1 and SW2, capacitors C1 and C2 and buffer amplifiers 54 and 56 and a difference output from the subtractor 58 is detected as a tracking error signal.

[0033] The analog switches SW1 and SW2 are connected to contacts a during the pit period and the fall time Δt of the reflected beam waveform to provide the detected signal without holding and, accordingly, momently changing tracking error signals are directly provided. The analog switches SW1 and SW2 are connected to contacts b during the bottom period excluding the fall time Δt of the reflected beam waveform. In this case, immediately preceding signals are held by the capacitors C1 and C2 and tracking error signals held at a predetermined value are provided.

[0034] An example of the laser power control by the laser power control section 25 of Fig. 1 is shown in Fig. 6. To a laser diode 60 in the optical head 13 are connected constant current circuits 62, 64 and 84 in parallel and these constant current circuits 62, 64 and 84 are driven by a power source + V. The constant current circuit 62 serves as a playback drive current source and

supplies a drive current I_1 corresponding to reference voltage V_{ref1} produced by a reference voltage generator 96. The constant current circuit 64 supplies a drive current I_2 corresponding to reference voltage V_{ref2} produced by a reference voltage generator 98 and constitutes a recording drive current source in combination with the constant current circuit 62. The constant current circuit 84 supplies a drive current I_3 which serves as a compensation current for compensating for a delay portion in rising of the laser power (pit power) when the operation mode of the device is changed from the playback mode to the record mode.

[0035] In the playback mode, the switch 66 is on and the switch 68 is off and the constant current circuit 62 only is in operation so that the laser diode 60 is continuously driven with only the playback drive current I_1 . This playback drive current I_1 causes the laser diode 60 to produce a laser beam output of a relatively low power (i.e., the bottom power) which is lower than a threshold value for recording and is sufficient for playback only.

[0036] In the recording mode, the switch 66 is on and the constant current circuit 62 is continuously driven. The switch 68 is also on and the constant current circuit 64 is driven intermittently according to turning on and off of the switch 70 by a signal to be recorded. Therefore, in the recording mode, a signal current of the current value I_2 is superposed on the dc current of the current value I_1 to drive the laser diode 60. The value $I_1 + I_2$ causes the laser diode 60 to produce a laser beam output (pit power) larger than the threshold value for recording and thereby enables recording on the optical disk 10.

[0037] In the recording mode, the values of the reference voltages V_{ref1} and V_{ref2} are changed in accordance with the recording speed increase ratio. In other words, the reference voltage generator 96 increases the value of the reference voltage V_{ref1} as the recording speed increase ratio increases. This causes both the pit power and the bottom power to be increased with the increase of the recording speed increase ratio. The value of the reference voltage V_{ref1} is set to values which are sufficiently low to prevent an erroneous forming of a pit in the bottom period at each of the recording speed increase ratios. The reference voltage generator 98 causes the reference voltage V_{ref2} to be changed in accordance with the recording speed increase ratio to compensate for shortage or surplus in the pit power to provide an optimum pit power at each recording speed increase ratio when increase in the reference voltage V_{ref1} produces such shortage or surplus.

[0038] In the ALPC circuit, the output of the laser diode 60 is detected by a laser beam detector 72 and applied to error amplifiers 78 and 80 through a converting amplifier 74 and a holding amplifier 76. The error amplifiers 78 and 80 produce errors between the detected laser beam output and the reference voltages V_{ref1} and V_{ref2} and cause the constant current values I_1 and I_2 to be changed in accordance with these errors to maintain the laser beam output at a constant value.

[0039] In switching the operation mode from the playback mode to the recording mode for the write-once recording on the disk 10, the compensation current source 84 is driven for compensating for the delay in rising of the laser beam output immediately after switching of the operation mode. The compensation current source 84 supplies to the diode 60 a current value corresponding to difference between the current value of the constant current circuit 64 and a predetermined drive current reference value as the current I_3 .

[0040] The operation of the circuit of Fig. 6 is shown in Figs. 7A to 7C. When it is desired to carry out the write-once recording, the laser diode 60 is initially driven in the playback mode (0.7 mW in this example) to feed the optical head 13 radially outwardly from the innermost position for conducting a search for an end point of a recorded portion. Upon detecting a track in which the end point of the recorded portion exists, a pause state is brought about (i.e., the same track is traced). Then, drive of the laser diode 60 is changed to the recording mode at a timing of passing the end point of the recorded portion for switching the operation mode to the recording mode to start recording.

[0041] In the example of Fig. 7, the pit power and the bottom power are changed in the following manner in accordance with the recording speed increase ratio.

	pit power	bottom power
Normal speed	6.5	0.7
double speed	9.0	1.0
quadruple speed	13.0	1.4

[0042] According to this change of the laser power, not only the pit power but also the bottom power are increased as the recording speed increase ratio increases and, therefore, difference between the pit power and the bottom power is reduced as compared with a case where the pit power only is increased. Accordingly, the fall time Δt of the reflected beam waveform undergoes little change and an adequate period of time is available for detecting a tracking error even at a high recording speed increase ratio. This ensures an excellent signal-to-noise ratio in the wobble signal. Further, since the bottom power is increased, a sharp leading edge of the pit power for a next pit period can be obtained with resulting reduction in the delay in the pit start position.

[0043] A specific example of the circuit of Fig. 6 is shown in Fig. 8. A signal to be recorded is applied to one transistor 88 which constitutes a differential amplifier 86 with another transistor 90. A laser diode 60 is inserted on the collector side of the other transistor 90 and is driven in response to the signal to be recorded.

[0044] Two constant current circuits consisting of tran-

sistors 64 and 84 are connected to a common emitter of the differential amplifier 86. To the cathode of the laser diode 60 is connected a constant current circuit consisting of a transistor 60 through an inductance 83. This inductance 83 is provided for preventing an undesirable influence by the switching operation current on the side of the differential amplifier 86 on the constant current circuit consisting of the transistor 62.

[0045] Among these constant current circuits, the transistor 62 supplies the playback drive current I_1 , the transistor 64 the current I_2 in the recording drive current $I_1 + I_2$ and the transistor 84 the compensation current I_3 . An integration type loop filter 82 is inserted in a control path of the drive current I_2 and the compensation current I_3 is controlled by the output of this loop filter 82. The loop filter 82 is provided for stabilizing the ALPC loop characteristics and preventing possible flow of rush current to the laser diode 60 and resulting damage to the laser diode 60 or shortening of its life in the case of unexpected conduction of the switch 68.

[0046] This loop filter 82 caused a delay in rising of the drive current I_2 in switching from the playback mode to the recording mode. Since, however, the output of the loop filter 82 is applied to a subtractor 94 which receives also a mode switching signal as a reference signal, the transistor 84 is controlled by a difference output from the subtractor 94 to supply the compensation current I_3 and, therefore, the delay in rising of the drive current I_2 is corrected.

[0047] In the above described embodiment, recording is made on the basis of the CD-WO standard. This invention however is applicable to recording on an optical disk on the basis of other standards.

[0048] In the above described embodiment, recording is made on a dye type optical disk. The invention however is applicable to various other types of optical disks including a metal type optical disk.

[0049] In the above described embodiment, the tracking error detection is made in the bottom period. The invention is applicable also to an optical disk recording device in which the tracking error detection in the bottom period is not made. In this case, the advantageous result that a sharp leading edge in the pit power for a next pit period is obtained with resulting reduction in the delay in the pit start position can still be obtained.

[0050] In the above described embodiment, the pit level and the bottom level are increased over the entire pit period and bottom period. Alternatively, the pit level and/or the bottom level may be increased in only a part of the pit period and/or the bottom period. For example, if the laser power in a former half of the bottom period is increased, the trailing edge of the reflected laser beam waveform will be shortened and, if the laser power in a latter half of the bottom period is increased, the leading edge of the pit power in a next pit period will become sharpened.

[0051] In the above described embodiment, no particular consideration has been given to the linear velocity.

5 A control may additionally be made so that the pit power and the bottom power will be changed in accordance with the linear velocity (1.2 m/s to 1.4 m/s in the CD-WO standard), i.e., the pit power and the bottom power will be increased as the linear velocity is increased.

Claims

1. An optical disk recording device for forming a pit or mark on an optical disk (10) by projecting a recording laser beam (11) onto said disk, for an amount of time corresponding to a length of the pit or the mark to be formed comprising:

10 recording speed setting means (28) for setting a recording speed;

rotation control means (16) for rotating the optical disk at a recording speed set by the recording speed setting means;

15 laser power control means (25) for controlling the laser power of the recording laser beam in a pit or marking period and the laser power of the recording laser beam in a bottom or non-marking period in such a manner that both the laser power in at least a part of the pit or marking period and the laser power in at least a part of the bottom or non-marking period will be increased as the set recording speed is increased;

20 tracking error detection means (31) for detecting a tracking error from the laser beam reflected during the bottom or non-marking period, of the recording mode and producing a tracking error signal during the recording mode.

25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640 645 650 655 660 665 670 675 680 685 690 695 700 705 710 715 720 725 730 735 740 745 750 755 760 765 770 775 780 785 790 795 800 805 810 815 820 825 830 835 840 845 850 855 860 865 870 875 880 885 890 895 900 905 910 915 920 925 930 935 940 945 950 955 960 965 970 975 980 985 990 995 1000 1005 1010 1015 1020 1025 1030 1035 1040 1045 1050 1055 1060 1065 1070 1075 1080 1085 1090 1095 1100 1105 1110 1115 1120 1125 1130 1135 1140 1145 1150 1155 1160 1165 1170 1175 1180 1185 1190 1195 1200 1205 1210 1215 1220 1225 1230 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2235 2240 2245 2250 2255 2260 2265 2270 2275 2280 2285 2290 2295 2300 2305 2310 2315 2320 2325 2330 2335 2340 2345 2350 2355 2360 2365 2370 2375 2380 2385 2390 2395 2400 2405 2410 2415 2420 2425 2430 2435 2440 2445 2450 2455 2460 2465 2470 2475 2480 2485 2490 2495 2500 2505 2510 2515 2520 2525 2530 2535 2540 2545 2550 2555 2560 2565 2570 2575 2580 2585 2590 2595 2600 2605 2610 2615 2620 2625 2630 2635 2640 2645 2650 2655 2660 2665 2670 2675 2680 2685 2690 2695 2700 2705 2710 2715 2720 2725 2730 2735 2740 2745 2750 2755 2760 2765 2770 2775 2780 2785 2790 2795 2800 2805 2810 2815 2820 2825 2830 2835 2840 2845 2850 2855 2860 2865 2870 2875 2880 2885 2890 2895 2900 2905 2910 2915 2920 2925 2930 2935 2940 2945 2950 2955 2960 2965 2970 2975 2980 2985 2990 2995 3000 3005 3010 3015 3020 3025 3030 3035 3040 3045 3050 3055 3060 3065 3070 3075 3080 3085 3090 3095 3100 3105 3110 3115 3120 3125 3130 3135 3140 3145 3150 3155 3160 3165 3170 3175 3180 3185 3190 3195 3200 3205 3210 3215 3220 3225 3230 3235 3240 3245 3250 3255 3260 3265 3270 3275 3280 3285 3290 3295 3300 3305 3310 3315 3320 3325 3330 3335 3340 3345 3350 3355 3360 3365 3370 3375 3380 3385 3390 3395 3400 3405 3410 3415 3420 3425 3430 3435 3440 3445 3450 3455 3460 3465 3470 3475 3480 3485 3490 3495 3500 3505 3510 3515 3520 3525 3530 3535 3540 3545 3550 3555 3560 3565 3570 3575 3580 3585 3590 3595 3600 3605 3610 3615 3620 3625 3630 3635 3640 3645 3650 3655 3660 3665 3670 3675 3680 3685 3690 3695 3700 3705 3710 3715 3720 3725 3730 3735 3740 3745 3750 3755 3760 3765 3770 3775 3780 3785 3790 3795 3800 3805 3810 3815 3820 3825 3830 3835 3840 3845 3850 3855 3860 3865 3870 3875 3880 3885 3890 3895 3900 3905 3910 3915 3920 3925 3930 3935 3940 3945 3950 3955 3960 3965 3970 3975 3980 3985 3990 3995 4000 4005 4010 4015 4020 4025 4030 4035 4040 4045 4050 4055 4060 4065 4070 4075 4080 4085 4090 4095 4100 4105 4110 4115 4120 4125 4130 4135 4140 4145 4150 4155 4160 4165 4170 4175 4180 4185 4190 4195 4200 4205 4210 4215 4220 4225 4230 4235 4240 4245 4250 4255 4260 4265 4270 4275 4280 4285 4290 4295 4300 4305 4310 4315 4320 4325 4330 4335 4340 4345 4350 4355 4360 4365 4370 4375 4380 4385 4390 4395 4400 4405 4410 4415 4420 4425 4430 4435 4440 4445 4450 4455 4460 4465 4470 4475 4480 4485 4490 4495 4500 4505 4510 4515 4520 4525 4530 4535 4540 4545 4550 4555 4560 4565 4570 4575 4580 4585 4590 4595 4600 4605 4610 4615 4620 4625 4630 4635 4640 4645 4650 4655 4660 4665 4670 4675 4680 4685 4690 4695 4700 4705 4710 4715 4720 4725 4730 4735 4740 4745 4750 4755 4760 4765 4770 4775 4780 4785 4790 4795 4800 4805 4810 4815 4820 4825 4830 4835 4840 4845 4850 4855 4860 4865 4870 4875 4880 4885 4890 4895 4900 4905 4910 4915 4920 4925 4930 4935 4940 4945 4950 4955 4960 4965 4970 4975 4980 4985 4990 4995 5000 5005 5010 5015 5020 5025 5030 5035 5040 5045 5050 5055 5060 5065 5070 5075 5080 5085 5090 5095 5100 5105 5110 5115 5120 5125 5130 5135 5140 5145 5150 5155 5160 5165 5170 5175 5180 5185 5190 5195 5200 5205 5210 5215 5220 5225 5230 5235 5240 5245 5250 5255 5260 5265 5270 5275 5280 5285 5290 5295 5300 5305 5310 5315 5320 5325 5330 5335 5340 5345 5350 5355 5360 5365 5370 5375 5380 5385 5390 5395 5400 5405 5410 5415 5420 5425 5430 5435 5440 5445 5450 5455 5460 5465 5470 5475 5480 5485 5490 5495 5500 5505 5510 5515 5520 5525 5530 5535 5540 5545 5550 5555 5560 5565 5570 5575 5580 5585 5590 5595 5600 5605 5610 5615 5620 5625 5630 5635 5640 5645 5650 5655 5660 5665 5670 5675 5680 5685 5690 5695 5700 5705 5710 5715 5720 5725 5730 5735 5740 5745 5750 5755 5760 5765 5770 5775 5780 5785 5790 5795 5800 5805 5810 5815 5820 5825 5830 5835 5840 5845 5850 5855 5860 5865 5870 5875 5880 5885 5890 5895 5900 5905 5910 5915 5920 5925 5930 5935 5940 5945 5950 5955 5960 5965 5970 5975 5980 5985 5990 5995 6000 6005 6010 6015 6020 6025 6030 6035 6040 6045 6050 6055 6060 6065 6070 6075 6080 6085 6090 6095 6100 6105 6110 6115 6120 6125 6130 6135 6140 6145 6150 6155 6160 6165 6170 6175 6180 6185 6190 6195 6200 6205 6210 6215 6220 6225 6230 6235 6240 6245 6250 6255 6260 6265 6270 6275 6280 6285 6290 6295 6300 6305 6310 6315 6320 6325 6330 6335 6340 6345 6350 6355 6360 6365 6370 6375 6380 6385 6390 6395 6400 6405 6410 6415 6420 6425 6430 6435 6440 6445 6450 6455 6460 6465 6470 6475 6480 6485 6490 6495 6500 6505 6510 6515 6520 6525 6530 6535 6540 6545 6550 6555 6560 6565 6570 6575 6580 6585 6590 6595 6600 6605 6610 6615 6620 6625 6630 6635 6640 6645 6650 6655 6660 6665 6670 6675 6680 6685 6690 6695 6700 6705 6710 6715 6720 6725 6730 6735 6740 6745 6750 6755 6760 6765 6770 6775 6780 6785 6790 6795 6800 6805 6810 6815 6820 6825 6830 6835 6840 6845 6850 6855 6860 6865 6870 6875 6880 6885 6890 6895 6900 6905 6910 6915 6920 6925 6930 6935 6940 6945 6950 6955 6960 6965 6970 6975 6980 6985 6990 6995 7000 7005 7010 7015 7020 7025 7030 7035 7040 7045 7050 7055 7060 7065 7070 7075 7080 7085 7090 7095 7100 7105 7110 7115 7120 7125 7130 7135 7140 7145 7150 7155 7160 7165 7170 7175 7180 7185 7190 7195 7200 7205 7210 7215 7220 7225 7230 7235 7240 7245 7250 7255 7260 7265 7270 7275 7280 7285 7290 7295 7300 7305 7310 7315 7320 7325 7330 7335 7340 7345 7350 7355 7360 7365 7370 7375 7380 7385 7390 7395 7400 7405 7410 7415 7420 7425 7430 7435 7440 7445 7450 7455 7460 7465 7470 7475 7480 7485 7490 7495 7500 7505 7510 7515 7520 7525 7530 7535 7540 7545 7550 7555 7560 7565 7570 7575 7580 7585 7590 7595 7600 7605 7610 7615 7620 7625 7630 7635 7640 7645 7650 7655 7660 7665 7670 7675 7680 7685 7690 7695 7700 7705 7710 7715 7720 7725 7730 7735 7740 7745 7750 7755 7760 7765 7770 7775 7780 7785 7790 7795 7800 7805 7810 7815 7820 7825 7830 7835 7840 7845 7850 7855 7860 7865 7870 7875 7880 7885 7890 7895 7900 7905 7910 7915 7920 7925 7930 7935 7940 7945 7950 7955 7960 7965 7970 7975 7980 7985 7990 7995 8000 8005 8010 8015 8020 8025 8030 8035 8040 8045 8050 8055 8060 8065 8070 8075 8080 8085 8090 8095 8100 8105 8110 8115 8120 8125 8130 8135 8140 8145 8150 8155 8160 8165 8170 8175 8180 8185 8190 8195 8200 8205 8210 8215 8220 8225 8230 8235 8240 8245 8250 8255 8260 8265 8270 8275 8280 8285 8290 8295 8300 8305 8310 8315 8320 8325 8330 8335 8340 8345 8350 8355 8360 8365 8370 8375 8380 8385 8390 8395 8400 8405 8410 8415 8420 8425 8430 8435 8440 8445 8450 8455 8460 8465 8470 8475 8480 8485 8490 8495 8500 8505 8510 8515 8520 8525 8530 8535 8540 8545 8550 8555 8560 8565 8570 8575 8580 8585 8590 8595 8600 8605 8610 8615 8620 8625 8630 8635 8640 8645 8650 8655 8660 8665 8670 8675 8680 8685 8690 8695 8700 8705 8710 8715 8720 8725 8730 8735 8740 8745 8750 8755 8760 8765 8770 8775 8780 8785 8790 8795 8800 8805 8810 8815 8820 8825 8830 8835 8840 8845 8850 8855 8860 8865 8870 8875 8880 8885 8890 8895 8900 8905 8910 8915 8920 8925 8930 8935 8940 8945 8950 8955 8960 8965 8970 8975 8980 8985 8990 8995 9000 9005 9010 9015 9020 9025 9030 9035 9040 9045 9050 9055 9060 9065 9070 9075 9080 9085 9090 9095 9100 9105 9110 9115 9120 9125 9130 9135 9140 9145 9150 9155 9160 9165 9170 9175 9180 9185 9190 9195 9200 9205 9210 9215 9220 9225 9230 9235 9240 9245 9250 9255 9260 9265 9270 9275 9280 9285 9290 9295 9300 9305 9310 9315 9320 9325 9330 9335 9340 9345 9350 9355 9360 9365 9370 9375 9380 9385 9390 9395 9400 9405 9410 9415 9420 9425 9430 9435 9440 9445 9450 9455 9460 9465 9470 9475 9480 9485 9490 9495 9500 9505 9510 9515 9520 9525 9530 9535 9540 9545 9550 9555 9560 9565 9570 9575 9580 9585 9590 9595 9600 9605 9610 9615 9620 9625 9630 9635 9640 9645 9650 9655 9660 9665 9670 9675 9680 9685 9690 9695 9700 9705 9710 9715 9720 9725 9730 9735 9740 9745 9750 9755 9760 9765 9770 9775 9780 9785 9790 9795 9800 9805 9810 9815 9820 9825 9830 9835 9840 9845 9850 9855 9860 9865 9870 9875 9880 9885 9890 9895 9900 9905 9910 9915 9920 9925 9930 9935 9940 9945 9950 9955 9960 9965 9970 9975 998

laser power in the pit or marking period which is smaller than a threshold value for recording; second reference voltage generation means (98) for generating a second reference voltage; and recording current supply means (64) responsive to the first and second reference voltages for supplying a drive current for recording which causes the laser power generation means to produce a laser power in the pit or marking period which is larger than the threshold value for recording.

4. An optical disk recording device as defined in claim 3 further comprising:

compensation current supply means (84) for supplying a drive current to the laser power generation means for compensating for a delay in rising of the laser power caused in switching an operation mode of the optical disk recording device from a playback mode to a recording mode.

5. An optical disk recording device as defined in anyone of claims 1-4 wherein recording is made on the basis of CD-WO standard.

Patentansprüche

1. Aufzeichnungsvorrichtung für eine optische Platte zum Formen einer Vertiefung oder Markierung auf einer optischen Platte (110) durch das Projizieren eines Aufzeichnungslaserstrahls auf die Platte, und zwar für einen Zeitraum, der der Vertiefungslänge der zu formenden Vertiefung entspricht, die folgendes aufweist:

Aufzeichnungsgeschwindigkeit-Einstellungs-
mittel (28), um eine Aufzeichnungsgeschwin-
digkeit einzustellen; Rotationssteuerungsmittel (16) zur Rotation der optischen Platte mit einer Aufzeichnungs-
geschwindigkeit, die durch die Aufzeichnungs-
geschwindigkeits-Einstellungsmittel eingestellt ist; Laserleistungssteuerungsmittel bzw. Laserleis-
tungsregelungsmittel (25) zur Steuerung bzw.
Regelung der Laserleistung eines Aufzeich-
nungslaserstrahls in einer Vertiefungs- oder
Markierungsperiode und der Laserleistung eines
Aufzeichnungslaserstrahls in einer
Boden- oder Nichtmarkierungperiode, und
zwar auf so eine Art und Weise, daß beide, die
Laserleistung in zumindest einem Teil der Ver-
tiefungs- oder Markierungsperiode und die
Laserleistung in zumindest einem Teil der
Boden- oder Nichtmarkierungsperiode erhöht

wird, wenn die eingestellte Aufzeichnungsgeschwindigkeit erhöht wird; Spureinstellungsfehler-Erfassungsmittel (31) zum Erfassen von Spureinstellungsfehlern von dem während der Bodenperiode des Aufzeichnungsmodus reflektierten Laserstrahls und zur Erzeugung eines Spureinstellungsfehler-
signals während des Aufzeichnungsmodus.

10 2. Aufzeichnungsvorrichtung für eine optische Platte nach Anspruch 1, die weiterhin aufweist:

Spureinstellungsfehler-Speichermittel (33) zur Weitergabe des Spurenstellungsfehler-
signals in einer Boden- oder Nichtmarkie-
rungsperiode ausschließlich einer Abfallzeit
des reflektierten Laserstrahls und zum Spei-
ichern und zum Ausgeben eines unmittelbar
vorhergehenden Spureinstellungsfehler-
signals in einer Vertiefungs- oder Markierungs-
periode und der Abfallzeit des reflektierten
Laserstrahls.

25 3. Aufzeichnungsvorrichtung für eine optische Platte nach Anspruch 1 oder 2, welche weiterhin Wiedergabemittel (35) und Laserleistungssteuerungsmittel bzw. Laserleistungsregelungsmittel aufweist, die Laserleistungssteuerungsmittel aufweisen:

erste Referenzspannungserzeugungsmittel (96) zur Erzeugung einer ersten Referenz-
spannung, welche erhöht wird mit der Erhö-
hung der Aufzeichnungsgeschwindigkeit;
Wiedergabestromversorgungsmittel (62), die,
ansprechend auf die erste Referenzspannung (96), einen Antriebsstrom liefert zur Wieder-
gabe, die die Laserleistungserzeugungsmittel veranlassen, eine Laserleistung in der Vertie-
fung oder Markierungsperiode zu erzeugen,
die geringer ist als ein Schwellenwert für die
Aufzeichnung;
zweite Referenzspannungserzeugungsmittel (98) zur Erzeugung einer zweiten Referenz-
spannung; und
Aufzeichnungsstromversorgungsmittel (64),
die, ansprechend auf die erste und zweite
Referenzspannung, einen Antriebsstrom liefert
zur Aufzeichnung, welcher die Laserleistungs-
erzeugungsmittel veranlaßt, eine Laserleistung
in der Vertiefungs- oder Markierungsperiode zu
produzieren, welche größer ist als der Schwellen-
wert zum Aufzeichnen.

50 4. Aufzeichnungsvorrichtung für eine optische Platte nach Anspruch 3, die weiterhin aufweist:

Kompensationsstromversorgungsmittel (84)
zum Liefern eines Antriebsstroms an die Laser-

leistungserzeugungsmittel zum Kompensieren einer Verzögerung im Ansteigen der Laserleistung, verursacht durch das Umschalten des Betriebsmodus der Aufzeichnungsvorrichtung für eine optische Platte von einem Wiedergabemodus in einen Aufzeichnungsmodus. 5

5. Aufzeichnungsvorrichtung für eine optische Platte nach einem der vorherigen Ansprüche 1 bis 4, wobei das Aufzeichnen auf der Basis des CD-WO Standards erfolgt. 10

Revendications

1. Dispositif d'enregistrement de disque optique pour former une cavité ou un marquage sur un disque optique (10) en projetant un faisceau laser d'enregistrement (11) sur le disque pendant une durée qui correspond à la longueur de la cavité ou du marquage à former, comprenant : 15

un moyen de réglage de vitesse d'enregistrement (28) pour fixer une vitesse d'enregistrement ; 20

un moyen de commande de rotation (16) pour faire tourner le disque optique à une vitesse d'enregistrement fixée par le moyen de réglage de vitesse d'enregistrement ; 25

un moyen de commande de puissance du laser (25) pour commander la puissance du faisceau laser d'enregistrement pendant la durée de cavité ou de marquage et la puissance du faisceau laser d'enregistrement pendant une durée de fond ou de non marquage de sorte que la puissance laser pendant au moins une partie de la durée de cavité ou de marquage et la puissance laser pendant au moins une partie de la durée de fond ou de non marquage est augmentée tandis que la vitesse d'enregistrement fixée est augmentée ; 30

un moyen de détection d'erreur de poursuite (31) pour détecter une erreur de poursuite à partir du faisceau laser réfléchi pendant la durée de fond du mode d'enregistrement et pour produire un signal d'erreur de poursuite pendant le mode d'enregistrement. 35

2. Dispositif d'enregistrement de disque optique selon la revendication 1, comprenant en outre un moyen de maintien de signal d'erreur de poursuite (33) pour faire passer le signal d'erreur de poursuite dans une durée de fond ou de non-marquage excluant une durée de décroissance du faisceau laser réfléchi et pour maintenir et fournir le signal d'erreur de poursuite immédiatement précédent pendant une durée de cavité ou de marquage et la durée de décroissance du faisceau laser réfléchi. 40

3. Dispositif d'enregistrement de disque optique selon la revendication 1 ou 2, comprenant en outre un moyen (35) de reproduction et un moyen de génération de puissance laser, le moyen de commande de puissance laser comprenant : 45

un premier moyen de génération de tension de référence (96) pour fournir une première tension de référence qui est augmentée avec une augmentation de vitesse d'enregistrement ; un moyen de fourniture de courant de reproduction (62) agissant en réponse à la première tension de référence (96) pour fournir un courant de commande de reproduction qui amène le moyen de génération de puissance laser à produire une puissance laser pendant la durée de cavité ou de marquage qui est inférieure à une valeur de seuil d'enregistrement ; un second moyen de génération de tension de référence (98) pour produire une seconde tension de référence ; et un moyen de fourniture de courant d'enregistrement (64) en réponse aux première et seconde tensions de référence pour fournir un courant de commande d'enregistrement qui amène le moyen de génération de puissance laser à produire une puissance laser pendant la durée de la cavité ou du marquage qui est supérieure à la valeur de seuil d'enregistrement. 50

4. Dispositif d'enregistrement à disque optique selon la revendication 3, comprenant en outre :

un moyen de fourniture de courant de compensation (84) pour fournir un courant de commande au moyen de génération de puissance laser pour compenser un retard de montée de puissance laser lors de la commutation d'un mode de fonctionnement du dispositif d'enregistrement à disque optique d'un mode de reproduction à un mode d'enregistrement. 55

5. Dispositif d'enregistrement de disque optique selon l'une quelconque des revendications 1 à 4, dans lequel l'enregistrement est effectué sur la base d'un standard CD-WO.

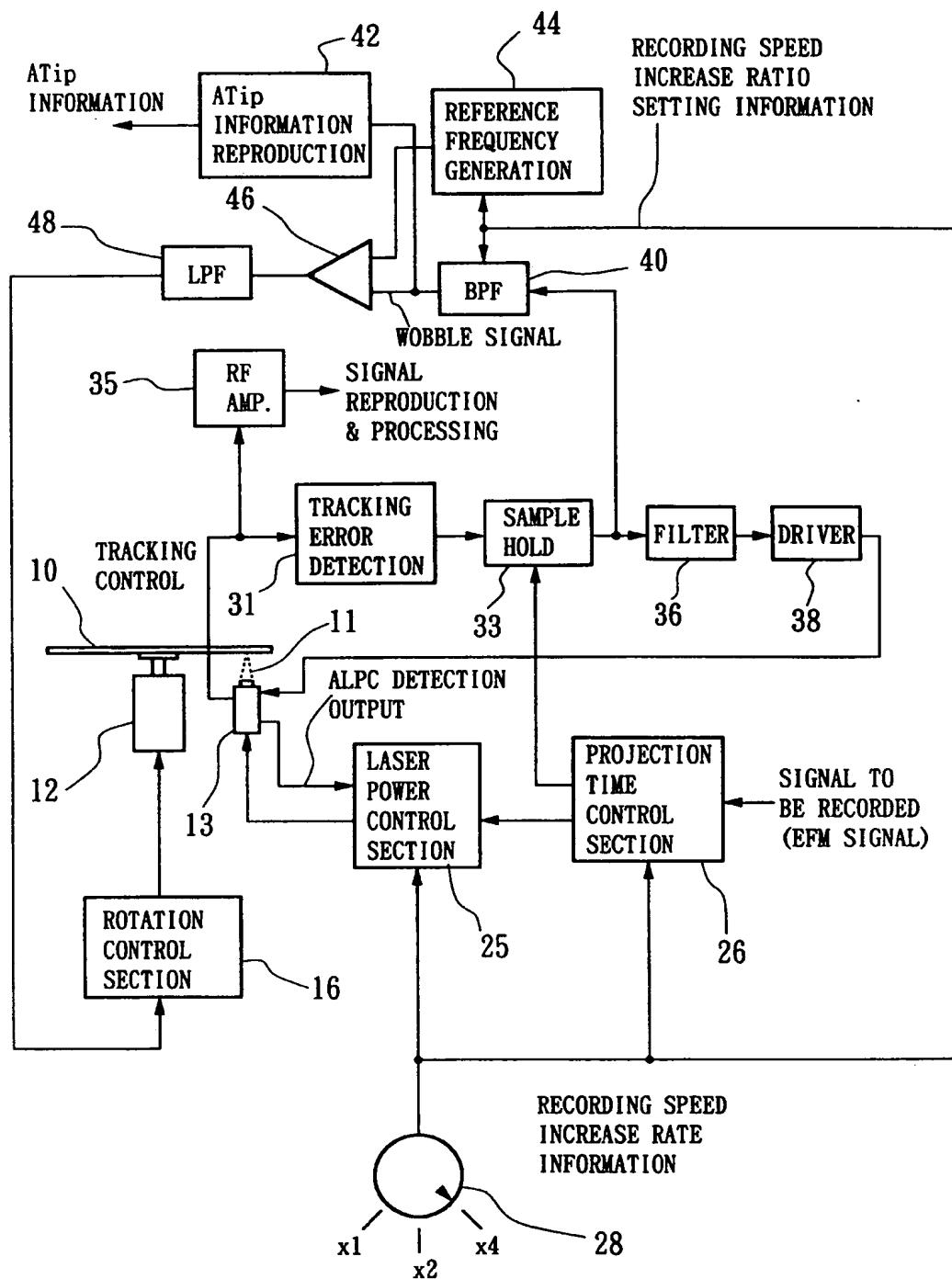


FIG. 1

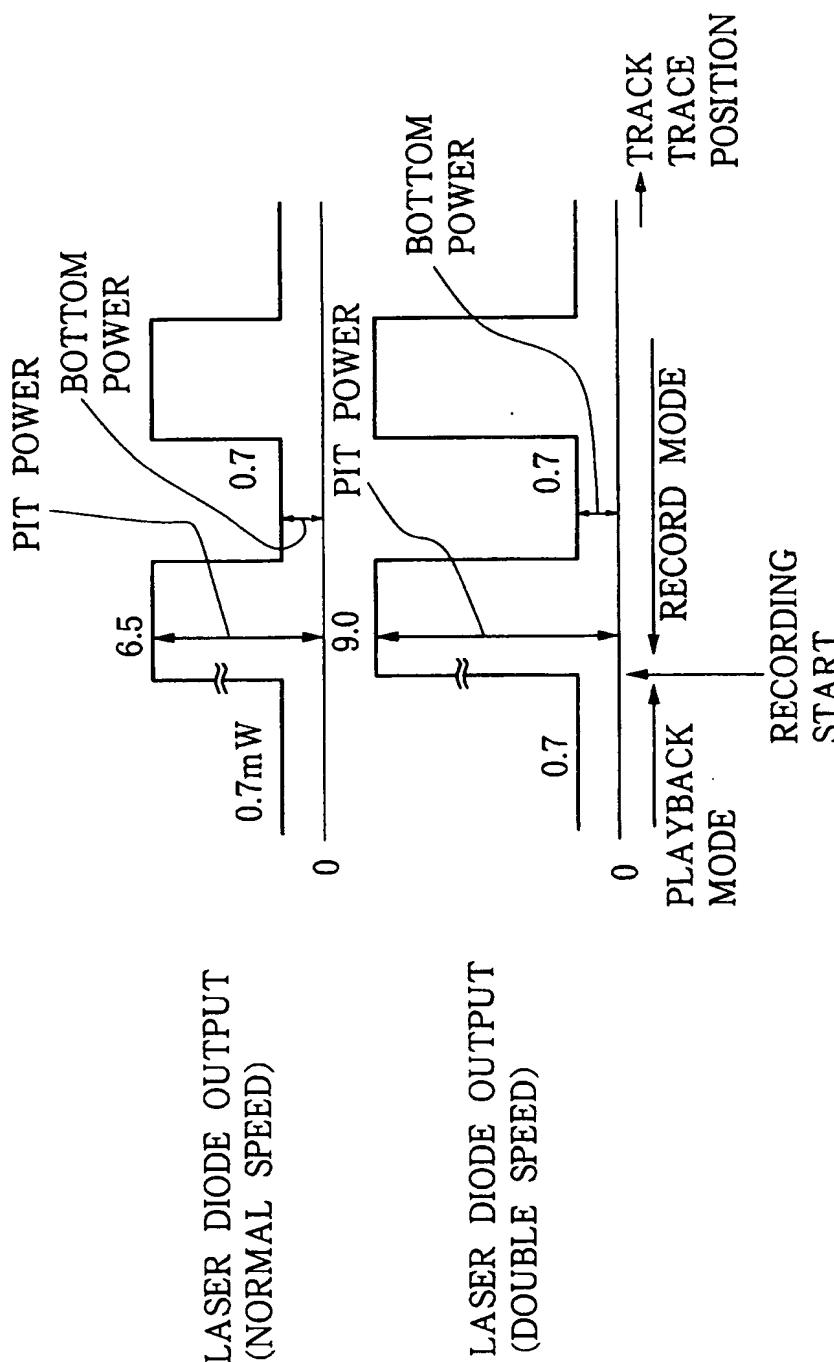
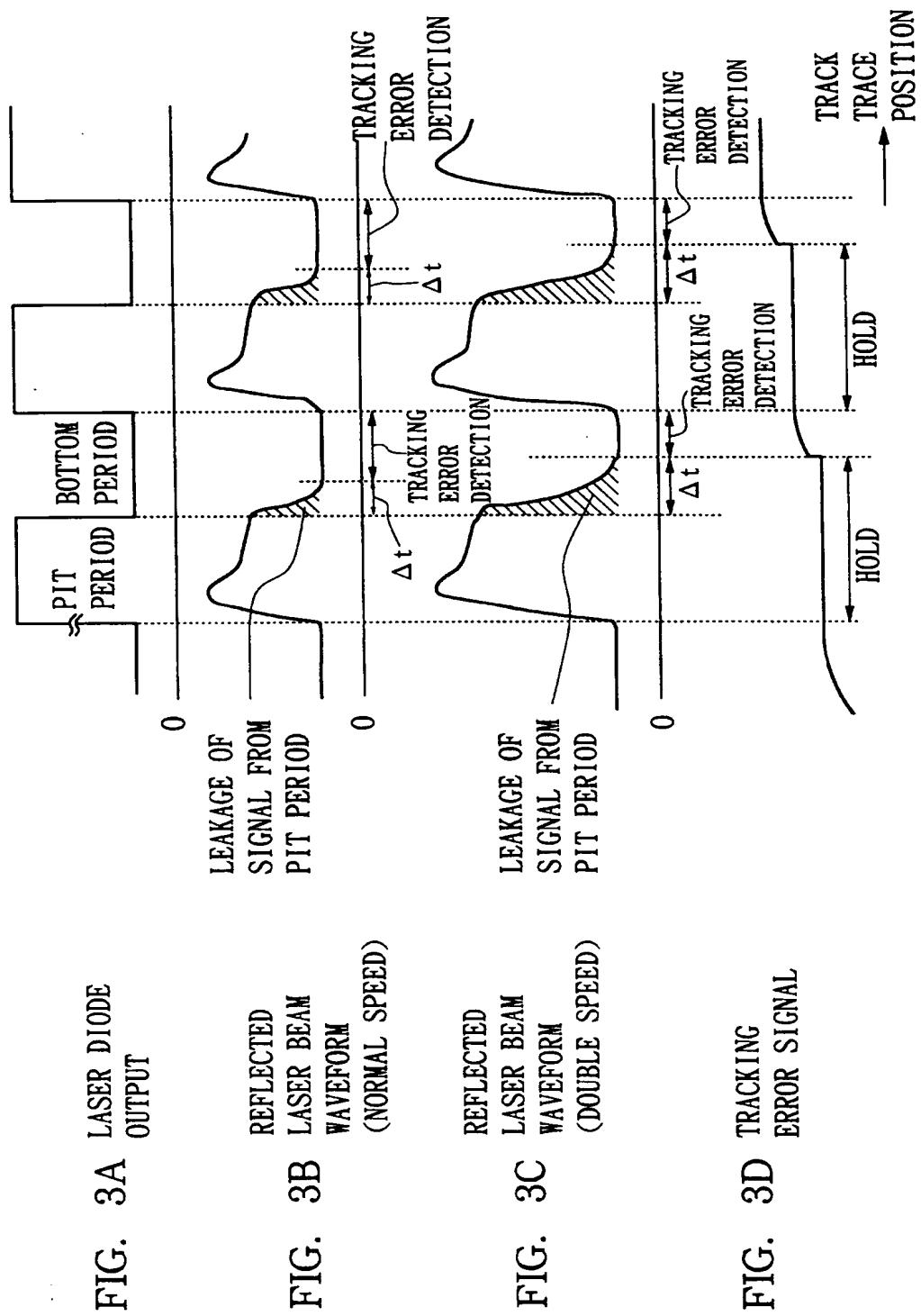


FIG. 2
PRIOR ART

FIG. 3A LASER DIODE OUTPUT



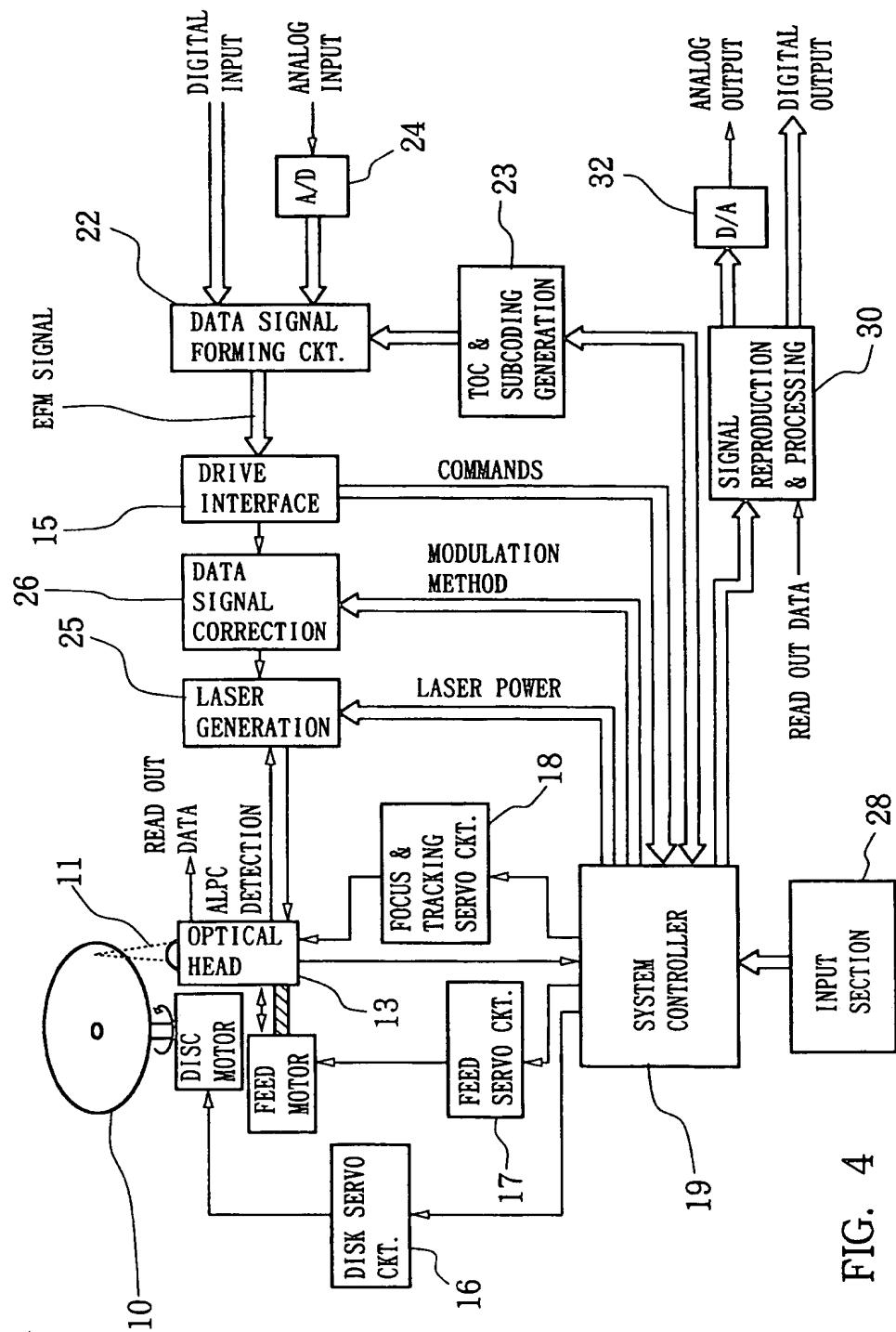


FIG. 4

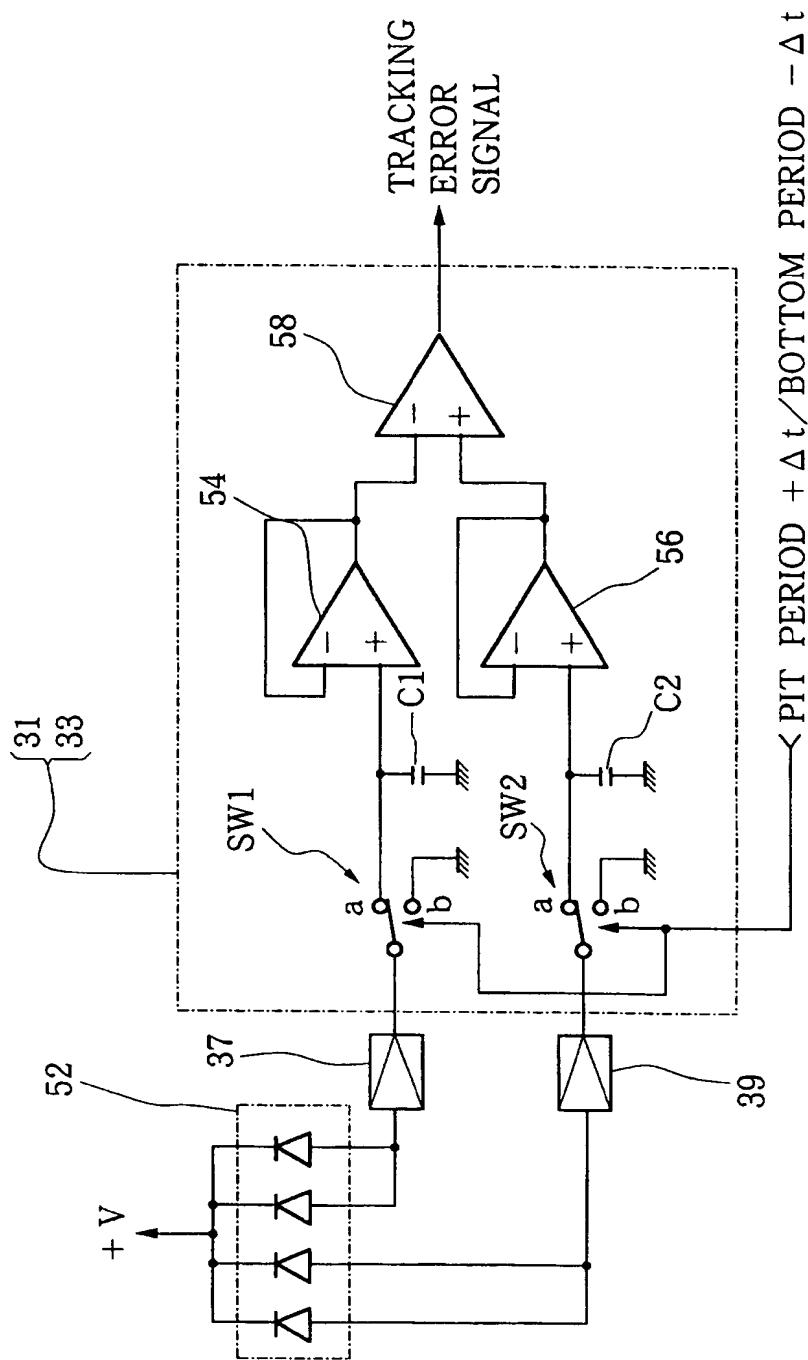


FIG. 5

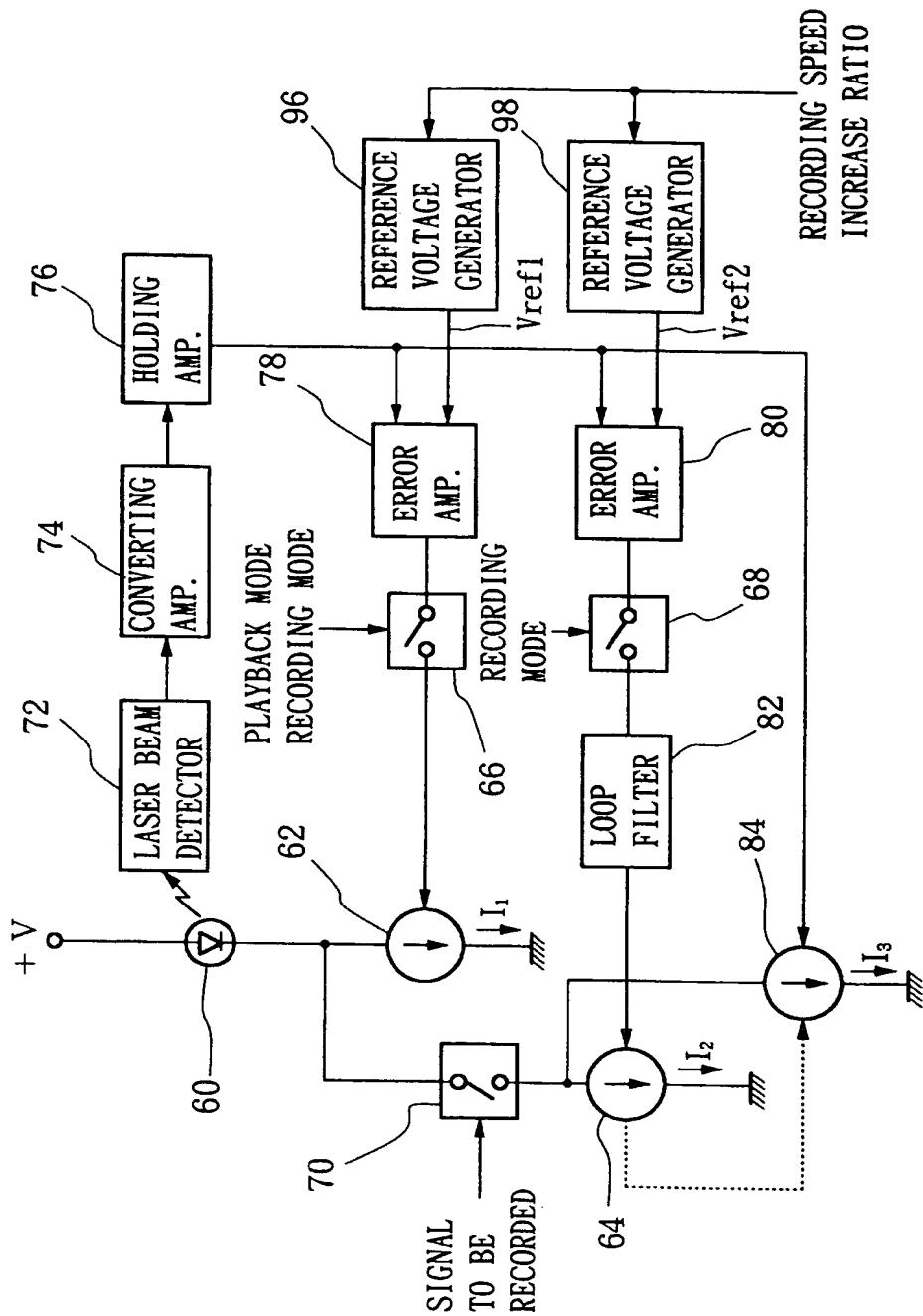
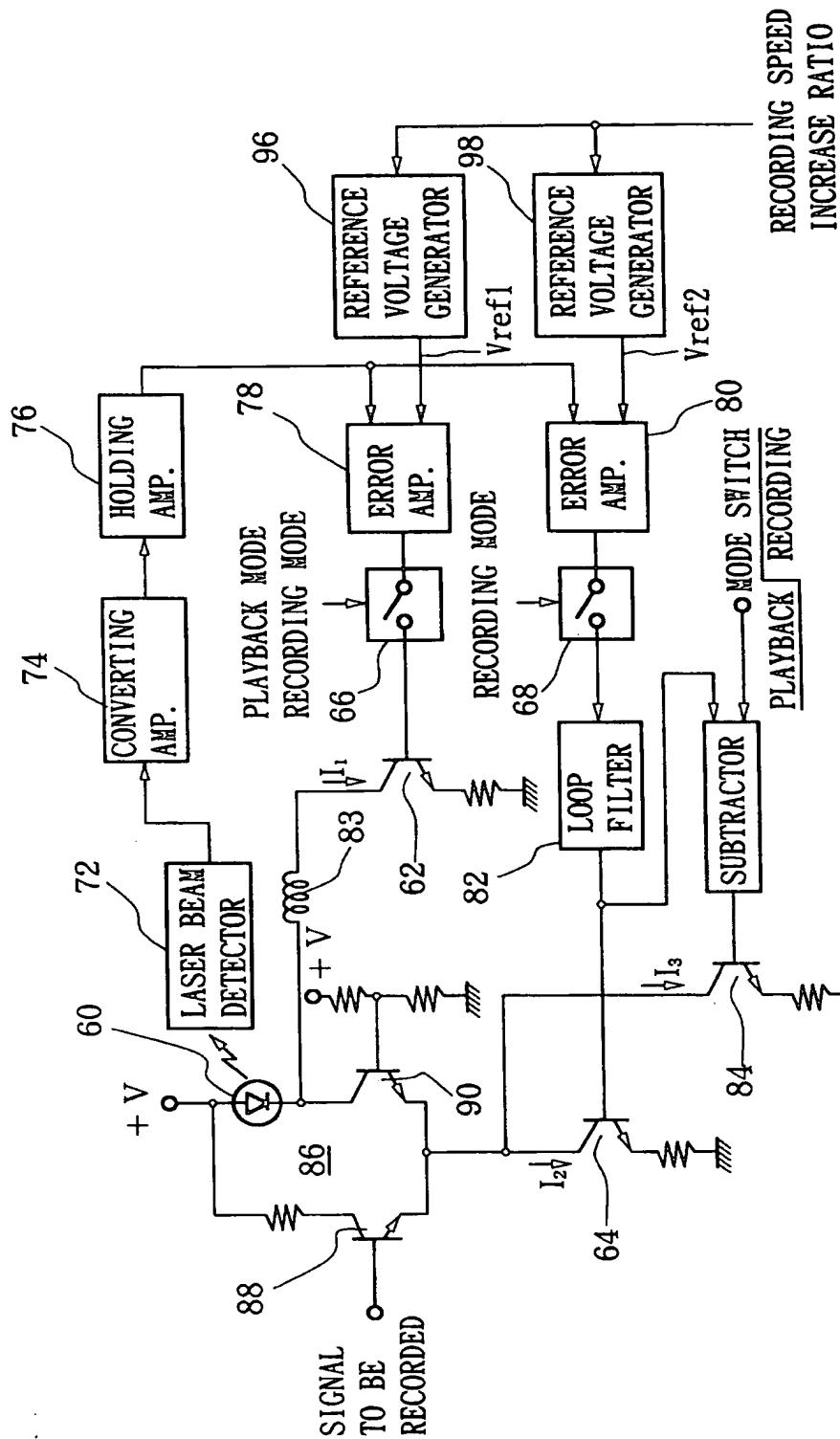


FIG. 6



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